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ABSTRACT

This study was designed to measure preservice teachers' confidence concerning interdisciplinary strategy, competence in using science as a content vehicle for teaching Reading/Language Arts (R/LA), and knowledge of components critical for integrating science and R/LA instruction. Elementary and/or special education juniors and seniors from three separate science methods sections and one language arts methods section were used in the study. Subjects in Treatment 1 were given integrated science and language arts methods instruction; Treatment 2, science methods instruction which included two hours of instruction on science as a content vehicle for teaching R/LA; Treatment 3, science methods instruction only; Control, language arts methods instruction only. Results of this study indicated that, in all instances, subjects in Treatment 1 did perceptively better than any of the other three group on all variables measured. Treatment 1 appeared to be the most powerful in raising students' confidence levels for using science as a content vehicle for teaching R/LA skills which could be taught using science as a content vehicle, and developing lessons which could be used to expand the vocabulary of children. (Author/MA)

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IMPROVING PRESERVICE ELEMENTARY TEACHERS' ATTITUDES AND KNOWLEDGE CONCERNING THE USE OF SCIENCE AS A CONTENT VEHICLE FOR LANGUAGE ARTS INSTRUCTION

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The problems facing elementary school teachers today are many. Numerous frustrations exist for the teacher who is expected to teach more content than ever before while, at the same time, face the constraints placed on the teacher by both the "back-to-basics" and "minimum-competency-testing" movements. Teachers are expected to focus on the teaching and measurement of the basic skills. At the same time, legal responsibilities often exist for other educational components such as career education, alcohol and drug abuse education, education for special populations, and a host of others. The elementary school appears to be drifting away from the traditional concept of a general education toward an education governed by a multitude of societal demands. This produces a distinct dilemma for the teacher who is interested in providing students with a quality general education program, while at the same time, meeting numerous added responsibilities.

Teachers who are caught in this dilemma and who decide to attempt to teach all that is required often find themselves in an impossible situation. On the other hand, if teachers decide to ignore the subjects they or society deem to be of lesser importance, they are probably denying students their rights to a well-rounded general education.

Although there are few, if any, easy answers to this problem, there are strategies available to make the situation more palitable. One of these is to

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integrate the teaching of the various subjects whenever possible. A prime candidate for such an integration is science. Hungerford and Tomera (1977) see science as having tremendous potential by noting:

> Those teachers who make a practice of approaching the educational experience from an interdisciplinary perspective find that science content is an excellent vehicle for use in other content areas. Science as a content vehicle has potential for skill development in reading, language arts, and mathematics. Students are given an opportunity to draw upon their science knowledge for the development of experience charts in reading, various communication activities in the language arts, and in problem solving in mathematics. Because most children seem inherently interested in many science topics, they are prone to utilize these interests in the development of skills in other areas to a much greater extent than if the content used is only of a passing interest. (p. 14)

In particular, one finds numerous educators who promote the idea of using science as a vehicle for reading/language arts (R/LA) instruction. Among these are Hudgins and Reed (1969); Davis and Miller (1973); Esler and Merritt (1976); Barufaldi and Swift (1977). Esler and Merritt put it quite well by stating:

> The use of manipulative material to teach reading and language arts is more than an integration of these skills with science. It is a true merger wherein each traditional subject matter loses its identity and blends into a single experience with concomitant skills that encompass all of them. Science-time, reading-time, and language arts-time become one, relieving the teacher of planning, scheduling and providing materials for separate exercises. Of even greater importance, the children learn to read. (pp. 205-206)

Although the authors of this article might question the veracity of a full-time blending of content to the point where identity is lost, the idea of fusing R/LA with science whenever appropriate is a sound one. Further, there exist many

similarities between the cognitive skills needed for skill with language and those utilized in the processes of science. Hence, the two areas are, potentially, supportive of each other.

Empirical evidence exists to support the thesis that science and language arts can be mutualistic. Several studies (Ayers and Mason, 1969; Neuman, 1970; Renner et al, 1973) indicate there is a significant relationship between student involvement with hands-on science activities and development of reading readiness skills. In another study conducted by Renner et al (1974) it was found that experiences with SCIS (Science Curriculum Improvement Study) greatly enhanced first-grade students' abilities to think logically which in turn contributes to a student's readiness to read. Further, Huff and Languis (1973) found that disadvantaged kindergarten children who were involved with the SAPA (Science: A Process Approach) program did significantly better than those not involved on language output, vocabulary, general meaning and skills, sentence structure, defining words, and listening.

The research cited above strongly supports the argument that hands-on science experiences help young children develop language and logic - both extremely important reading readiness skills. Research, however, on the relationship between involvement with hands-on science programs and R/LA skill development beyond the primary grades is sparse. Nevertheless, research conducted by Renner et al (1973) and Linn and Thier (1975) indicate that providing hands-on science experiences for older children can be effective in strengthening the thinking skills needed for effective content area reading.

Renner et al (1973) investigated the potential of SCIS for improving student competencies in a number of areas. The question asked was, "Do experiences with the SCIS program influence the achievement of fifth-graders in mathematics, reading, and social studies?" The results of this research

demonstrated that there were significant differences between students who participated in SCIS and those who were not so involved in the areas of math applications, social studies skills, and paragraph meaning. No significant differences, however, were reported for math skills and concepts, social studies content, and word meaning. The investigators state:

> In the data which have just been presented there is a very important thread that runs through them. Notice that the experimental group scored significantly better on paragraph meaning, mathematics application and social studies skills, i.e., using skills . . . to solve problems. If you carefully consider what is being said, you will find that the children is [sic] the experimental group excelled the control group in one ability only - - - the ability to inquire and use the thinking needed to accomplish it. That is what experience with the SCIS program has done for children in the experimental group. (p. 313)

In addition, Linn and Thier (1975) found that fifth-graders who had the "Energy Sources" unit of SCIS were better logical thinkers than those who did not have that unit. However, the study did not measure student improvements in R/LA.

Although studies exist which point to the mutualistic potential for integrating science and language arts, there is no evidence in the literature to suggest ways of developing teacher competencies from a methodological perspective. This situation led the writers to develop an integrated science and language arts methods course for providing instruction for preservice elementary education majors at Southern Illinois University at Carbondale (SIU-C) which would, hopefully, result in improved competencies in using science as a content vehicle for R/LA instruction and increased confidence in using this strategy. Similarly, the writers attempted to measure empirically the effect that this integration of methods had on preservice elementary education majors.

THE INTEGRATED METHODS COURSE

During the 15 week Spring Semester of 1978, the writers implemented an integrated science and R/LA methods course at SIU-C for the purpose of facilitating teachers' use of science as a content vehicle for the teaching of R/LA skills to children. The course consisted of four hours of instruction per week. Whereas the traditional science methods course incorporated only two hours of instruction per semester on integrating science and the R/LA's, the integrated methods course involved a minimum of fifteen (15) hours of this instruction. This was made possible by adding one hour of instruction to the three hours normally involved in the course. It should be noted, however, that the students enrolling in the integrated methods section were not taking this course in lieu of the language arts and reading methods courses in the elementary education program.

The content in the integrated methods course consisted of the traditional science methods components plus instruction in the use of science as a content vehicle for reading and language arts instruction. Nearly fifty percent of the methods course time was spent in instruction dealing with the process components, i.e., experiential, inductive, hands-on science instruction. Other topics normally covered in the science methods course included understanding science and technology, a rationale for science instruction, science textbook programs, science and environmental education, and science in special education. In the integrated methods course, these topics were supplemented. Additional topics, of particular concern to R/LA, included critical thinking skills, techniques for using hands-on science experiences for developing language experience stories, and how to use the language experience stories as diagnostic tools with respect to both science and R/LA skills and concepts. In addition,

students were required to conduct an experiential science lesson with children and use that experience to develop a language experience story.

THE RESEARCH STRATEGY

In an effort to determine the efficacy of the instructional model represented by the integrated methods course, a research study was designed to measure preservice teachers' confidence concerning the interdisciplinary strategy, their competence in using science as a content vehicle for the teaching of R/LA, and their knowledge of components critical for integrating science and R/LA instruction. This study took place during the 1978 Spring Semester and utilized three separate science methods sections as treatment groups and one language arts methods section as a control. All sections were represented by juniors and seniors in elementary and/or special education. Group characteristics were as follows:

Gp. 1 (N=19) Treatment 1: Integrated science and language arts methods instruction. Instruction for this group is described in the prior section.

Gp. 2 (N=16) Treatment 2: Science methods instruction. Instruction for this group consisted of the regular course content which includes two hours of instruction on science as a content vehicle for the teaching of R/LA.

Gp. 3 (N=20) Treatment 3: Science methods instruction. Instruction for this group consisted of the regular course content minus instruction on science as a content vehicle for R/LA.

Gp. 4 (N=26) Treatment 4: Language arts methods instruction. This group received standard methods instruction with no modification.

Because random assignment to groups was impossible, groups were equated on each of five variables. Since there were no significant differences among the groups, they were considered equivalent for research purposes. These data are

found in Table 1.

Insert Table 1 about here

An instrument was developed specifically for the purpose of measuring the variables under investigation in this research.[1] Numerous demographic variables were also assessed including GPA, courses taken, year in school, and sex. None of the demographics was found to correlate significantly with the variables under investigation. Specifically, this instrument measured preservice teachers' confidence level for using science content to teach R/LA skills (using a Likert-type scale), the discrete critical thinking skills students thought were common to both science and R/LA, and the R/LA skills students believed they could teach using science as a content vehicle. In addition, students were asked to describe one example of a science lesson that could be used to develop the vocabulary of elementary school children and the procedures they would use in implementing said lesson. This instrument was used on a pre-post basis with the research design seen in Figure 1.

Insert Figure 1 about here

THE FINDINGS

In a majority of cases, data collected were analyzed in two ways: 1) On a within group basis using a dependent t test, and 2) on a between group basis using one-way analysis of variance with the application of the Scheffe test (Ferguson, 1966). Data are reported below for each discrete variable and measurement.

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1. A copy of this instrument can be obtained by writing to the senior author.

Variable 1. Students' confidence level for using science content to teach language arts skills was measured with a Likert-type item yielding scores ranging from 1 - 5. The higher the score, the greater the confidence.

Insert Table 2 about here

Between group comparisons for this variable, using one-way analysis of variance with gain scores yielded: $F = 8.657$; $p = .0001$; $R^2 = 25.22$ percent. Applying the Scheffe test, comparing groups at the .01 level, Treatments 1 and 2 were found to be different from Treatment 4. Treatment 3 was not different from any of the others at the .01 level of significance.

Findings related to this variable indicate that all science methods treatments were effective in raising students' confidence levels for using science as a content vehicle for teaching R/LA skills. Treatment 1 (the integrated methods course) appears, however, to be the most powerful for generating a relatively high confidence level on a pre to post basis. Interestingly, the regular language arts methods course did little to increase the confidence levels of the students.

Variable 2. Those critical thinking skills students identified as common to both science and R/LA were measured by an open-ended question yielding a raw score. Each discrete skill listed provided the respondent with one raw score point.

Insert Table 3 about here

Between group comparisons on this variable, using one-way analysis of variance with gain scores yielded: $F = 9.896$; $p = .000$; $R^2 = 42.94$ per cent. Applying the Scheffe test, comparing groups at the .01 level of significance,

Treatment 1 was statistically different from all other treatments.

Findings relative to this variable indicate that the integrated methods course was a very powerful treatment for transmitting knowledge of the critical thinking skills common to both science and R/LA. Treatment 2, which incorporated both instruction on science process and integrating science with R/LA, also proved to be effective in this dimension. However, in Treatments 3 and 4, the pre to posttest differences were not significant at the .05 level.

Variable 3. Those R/LA skills that students thought they could teach using science as a content vehicle were measured by an open-ended question asking students to list those skills. Each discrete R/LA skill listed provided the respondent with one raw score point.

Insert Table 4 about here

Between group comparisons on this variable using one-way analysis of variance with gain scores yielded: $F = 9.896$; $p = .000$; $R^2 = 27.83$ per cent. Applying the Scheffe test, comparing groups at the .01 level of significance, Treatment 1 was found to be significantly different from all other treatments.

Findings on this variable initially appear discrepant. Groups 1, 2, and 4 all show significant pre to posttest differences. However, the content of language arts methods courses emphasizes R/LA skill development. Hence, the findings are not surprising because of this. Only Group 3 did not provide statistically significant differences pre to post. This group, of course, received no instruction on either R/LA skills or on using science as a content vehicle for teaching these skills. Treatment 1, therefore, remains the most powerful devide for producing changes on this variable as evidenced by the results of the Scheffe analysis.

Variable 4. The ability to develop a science lesson and describe the procedures used in implementing the lesson in a manner that could be used to expand the vocabulary of elementary school children constituded this variable. The specific item follows: "In a brief paragraph, please describe one example of a science lesson that could be used to expand the vocabulary of elementary school children. Also, briefly explain the procedures you would use to implement such a strategy."

This task was evaluated in terms of the efficacy of the lesson itself and whether or not the lesson developed used a deductive or an inductive approach. Further, an assessment was made relative to the R/LA strategies or activities which would, in fact, be used to develop vocabulary. Each discrete and appropriate R/LA activity described received one raw score point. This permitted the researchers to obtain group means pre and post and compare these means. These raw score means and the resulting t tests are reported in Table 5.

Insert Table 5 about here

Between group comparisons on this variable using one-way analysis of variance with gain scores yielded: $F = 9.943$; $p = .0001$; $R^2 = 23.63$. Applying the Scheffe test, comparing groups at the .01 level of significance, Treatment 1 was significantly different from Treatments 3 and 4 but not from Treatment 2.

These results indicate that Treatments 1 and 2 are both effective from a statistical perspective. However, the raw data provide evidence that Treatment 1 is a more powerful treatment than any of the others for training prospective teachers in the use of science as a content vehicle for vocabulary development.

Further, results on this variable indicate that the students in Group 1 were much better able to design either an inductive or deductive science lesson for vocabulary development than were students in any of the other groups. On the post-test, 94.74 per cent of the students in Treatment 1 were able to design such a lesson compared to 50.00 per cent in Treatment 2, 20.00 per cent in Treatment 3, and 26.92 per cent in the control group. Further, on the post-test, the students in Group 1 designed far more inductively oriented lessons than did the students in any of the other groups (Gp. 1 = 7; Gp. 2 = 2; Gp. 3 = 2; Gp. 4 = 1).

Ancillary variable. Data indicating the ability of preservice teachers to transfer direct instruction in the integration of content to assignments other than those provided by the researchers.

An interesting and unexpected finding appeared in this study as a result of an assignment given to all sections of science methods students (Gps. 1, 2, and 3) at SIU-C. Approximately midway in each semester the methods students are asked to do an indepth appraisal of a science textbook series of their choice. This assignment takes about one month to complete. It is composed of thirteen very specific tasks. The final task in this assignment is for the student to look back on the appraisal experience and describe how he/she would use the textbook to provide the best possible science program for children.

As the junior author evaluated the appraisals turned in by Group 1, it became clear that a number of students responded, in part, by describing how they would use the language experience method to help provide for a sound science/language arts program. Subsequently, he also examined the appraisals turned in by students in Groups 2 and 3. The results of this inspection are found in Table 6.

Insert Table 6 about here

It appears as though an intensive effort to teach teachers how to integrate content areas influences their behavior beyond assignments specifically directed toward this behavior. Interestingly, where no effort was made to provide instruction related to the integration of content, only one student in twenty responded thusly compared to nearly 50 per cent of those students in the integrated methods course. One is tempted to hypothesize that those students trained in the integration of science and the R/LA's will transfer this behavior into their own elementary classrooms to a much greater extent than those teachers not so trained.

DISCUSSION

The results of this research indicate that an integrated science/language arts methods course can be eminently successful in educating preservice teachers in the interdisciplinary strategies available for use in both science and language arts instruction. In all instances, the group which had an entire semester of instruction on strategies for integrating the teaching of science and language arts (Treatment 1) did perceptibly better than any of the other three groups on all variables measured.

Treatment 1 seems to be the most powerful in raising students' confidence levels for using science as a content vehicle for teaching R/LA skills, transmitting knowledge of the discrete critical thinking skills common to both science and R/LA, identifying those R/LA skills which could be taught using science as a content vehicle, and developing lessons which could be used to

expand the vocabulary of children. Results further indicate that although the group which had only two hours of instruction on techniques for using science as a content vehicle to teach the R/LA (Treatment 2) did not do as well as Treatment Group 1 on all variables measured, Treatment Group 2 did, in fact, perform better than Treatment Group3 and the Control Group on said variables. This indicates that direct instruction is necessary for preservice teachers to understand and apply the methods appropriate for integrating science and the R/LA. Therefore, it can be recommended that instruction be provided in order that preservice teachers have the confidence, knowledge, and competencies needed for developing lessons which integrate the teaching of science and language arts

When one considers the increasing demands on public education and competition among subject areas for a place in the curriculum, it is important for teacher education programs to include instruction in strategies which can be used by teachers to cope with this situation. Developing courses which include techniques for integrating the teaching of science and the language arts is a viable avenue teacher educators can take. This does not mean, however, that the writers are suggesting that all methods courses should be taught using an integrated approach. Indeed, it may be more germane for instructors of reading and language arts methods courses to include instruction on how to use the various content areas as vehicles to teach reading and language arts skills. Further, instructors of science methods courses may want to consider including instructional techniques for using science content and process in developing the critical thinking and language skills of children in their courses, especially since research points to the fact that hands-on science experiences help children develop language skills as well as those

logical thinking processes so necessary for effective reading.

When preservice teachers are trained in how to integrate the teaching of science and the R/LA's, there is a greater chance that this knowledge will be transferred into their classroom when compared to those teachers who did not have such training.

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TABLES AND FIGURES

Table 1 Variation between groups on selected pre-test variables for the purpose of determining group equality

Variable	F ratio	Probability
Grade point average (GPA)	2.203	.094
Confidence in using an integrated approach in the teaching of R/LA and science	1.613	.194
Knowledge of critical thinking skills common to science and R/LA	.179	.910
Those R/LA skills participants believed they could teach using science as a content vehicle	.542	.655
Ability to develop science lessons for vocabulary development	.539	.657

Group	Measurements, Treatments, and Dates
	[Jan. 23, 1978 ---------- May 5, 1978]
Gp. 1 (N=19)	O_1 ----------Treatment 1 ---------- O_2
Gp. 2 (N=16)	O_3 ----------Treatment 2 ---------- O_4
Gp. 3 (N=20)	O_5 ----------Treatment 3 ---------- O_6
Gp. 4 (N=26)	O_7 ----------Control Treatment ---------- O_8

Fig. 1. Research design showing groups, N size, treatments, dates, and observations.

Table 2 Within group comparison of confidence level means for using science content to teach R/LA skills

Group and treatment number	Pre-test mean	Post-test mean	t value	Probability
1	2.05	3.63	5.88	.000
2	2.57	3.93	4.18	.001
3	2.55	3.55	3.23	.004
4(C)	2.65	2.56	.40	.690

Table 3 Within group comparisons of raw score means indicating those critical thinking skills identified as common to both science and R/LA

Group and treatment number	Pre-test mean	Post-test mean	t value	Probability
1	.95	6.79	8.64	.000
2	.69	2.69	3.20	.006
3	.75	1.85	1.95	.067
4(C)	.96	1.62	1.89	.071

Table 4 Within group comparisons of raw score means indicating those R/LA skills students believed they could teach using science as a content vehicle

Group and treatment number	Pre-test mean	Post-test mean	t value	Probability
1	1.90	8.00	4.90	.000
2	2.38	3.88	3.29	.005
3	1.45	2.00	.85	.409
4(C)	1.96	3.69	3.33	.003

Table 5 Within group comparisons of raw score means attributed to the description of R/LA activities used to develop vocabulary using discrete science experiences

Group and treatment number	Pre-test mean	Post-test mean	t value	Probability
1	.47	2.37	6.42	.000
2	.00	.69	2.30	.036
3	.55	.15	.78	.444
4(C)	.35	.50	.70	.490

Table 6 Number and percentage of students responding to the textbook appraisal in terms of incorporating science and R/LA

Group and treatment number	Language experience response present	Total N	Percent of total
1	9	19	47.37 %
2	4	16	25.00 %
3	1	20	5.00 %

4(C) Not included in this analysis